Space Weather Technical Forecast

Issued on Friday, 14 April 2023 at 01:17 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity observed at GOES16 and 18 confined to occasional mid-ranking C-class flares. The largest of these flares was a C8.4 at 13/1043UTC from AR3272. This spot was one of the most complex on the visible disc in the period, with a span of 14 degrees solar longitude and Eai/Beta complexity. The flare appeared to emanate from its leading group, with its central spots otherwise fading over the 24 hours, partly counteracted by the development of a new trailing spot.

The above was one of up to eight sunspot regions on the current disc, with a new unnumbered bipolar region now also evident in the far northeast. The main trends in the current cohort of spots over the UTC day of Thursday 13 April included strong areal development in the leading spot of AR3281, but with the narrow viewing angle preventing further detail being seen. Also of note was AR3280, which saw proliferation of spots and growth throughout; while AR3272 saw some fading of its intermediate spots as a new trailer developed. Finally, AR3279 saw more modest changes in its central portion, with a reconfiguration of minor spots here.

There have been no Earth-directed CMEs observed in available imagery over the past 24 hours, with all minor coronagraph activity appearing comfortably limb-ward.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, followed a slow regime, with the solar wind speed falling slightly from an early Slightly Elevated 425km/s to a Background 390km/s. The solar wind density was within its normal range in single figures ppcc, while the IMF showed a declining tendency from 9nT to nearer 5. The north-south component varied between +8 and -7nT, with this mainly co-aligned with Earth's field at first, but becoming increasingly anti-aligned as the period evolved. The phi angle was away from the Sun throughout (positive).

The net result of the above solar wind measures was for provisionally Quiet to Unsettled geomagnetic activity, with this peaking with a Kp '3-' in the 00-03UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at Background levels.

The high energy electron flux (greater than 2MeV) as measured at GOES16 was at Normal Background levels. The associated 24-hour integrated electron fluence was below the Active threshold throughout, with the 14/0001UTC observed value being 1.69e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a Chance of isolated M-

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class flares.

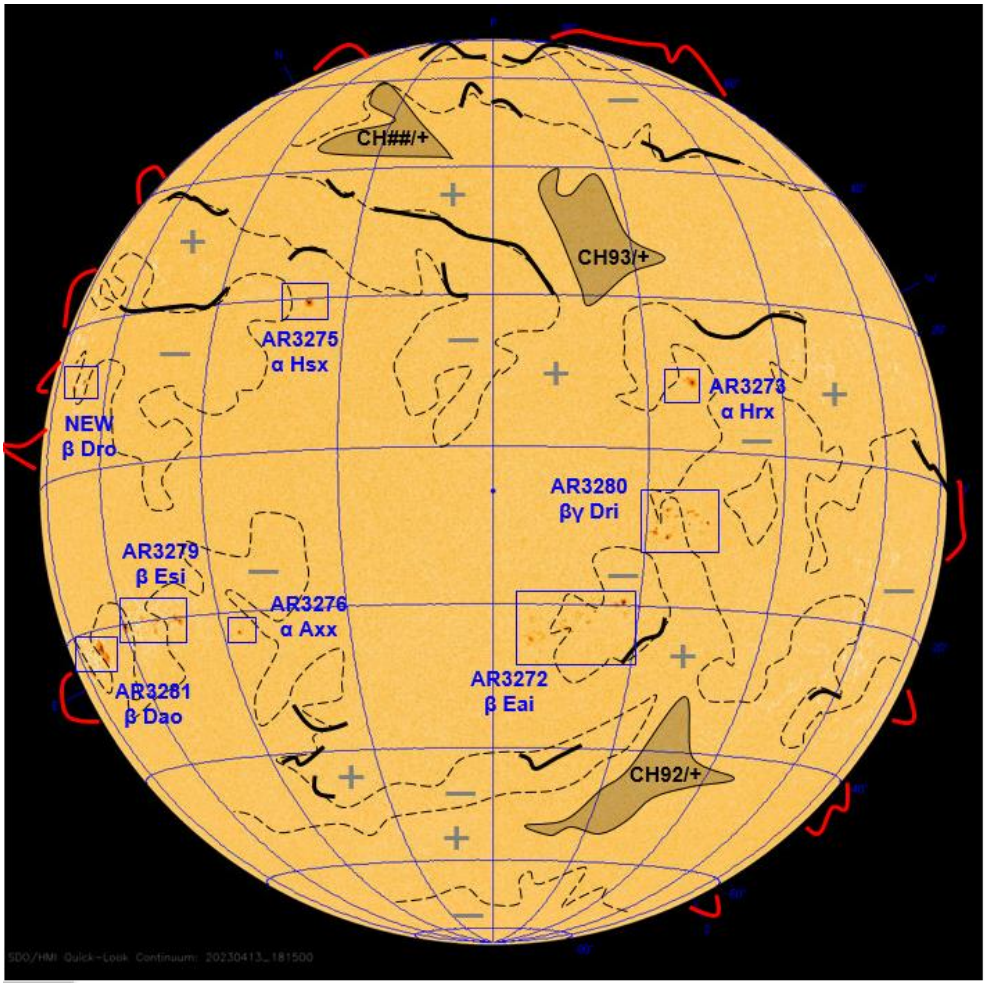
Solar Wind / Geomagnetic Activity: There is a low possibility of glancing CME arrivals on days one to three inclusive (Friday 14 to Sunday 16 April). Otherwise, solar winds are likely to remain at ambient levels at first, but may become slightly elevated later on 14 April due to positive coronal hole high speed streams.

Resulting geomagnetic activity is expected to generally be Quiet to Unsettled, with a Chance of Active intervals, most likely in association with any low confidence transitory CME impacts.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at Background levels, although there is a Slight Chance of a greater than S1 event, with a large and complex sunspot region transiting the western solar hemisphere.

High energy (greater than 2 MeV) electron flux is currently at Normal Background levels, but may see a modest rise over the coming days. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu), but perhaps with a rising trend.

Figure 1. Solar Analysis Valid 13/1815UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Regarding CMEs, there is a latent low-level risk of glancing impacts for days one to three inclusive (Friday 14 April to Sunday 16 April). This period is bookended by a risk from filament eruptions from the southwest quadrant on 09 and 12 April respectively, with a possible intervening CME from a dimming from 11/2000UTC. Confidence surrounding all three of these events is low.

In terms of fast wind regimes, Earth appears to have exited the HSS associated with CH91/+, with winds now within ambient levels. Further positive coronal holes CH92/+ in the south, and CH93/+ in the north carry a potential for Earth to see slightly elevated solar winds from later on day one (Friday 14 April) onwards, however due to their relatively high-latitude positions and positive polarity, any geomagnetic enhancement is expected to remain subdued, with limited MOSWOC Enlil support for any sizeable solar wind enhancement.

The forecast for geomagnetic activity is therefore for generally Quiet to Unsettled conditions throughout, but with a Chance of Active intervals, should any of the aforementioned glancing CME impacts materialise up to and over the UTC weekend.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/0220	Partial	filament	SW limb	540km/s	Imminent	Low chance of glancing blow
11/2000	N/A	Dimming	Centre-disc	N/A	UTC day of 15 April	Very low confidence
12/0959	Partial	filament	SW quadrant	550km/s	16/0300UTC	Low chance of glancing blow

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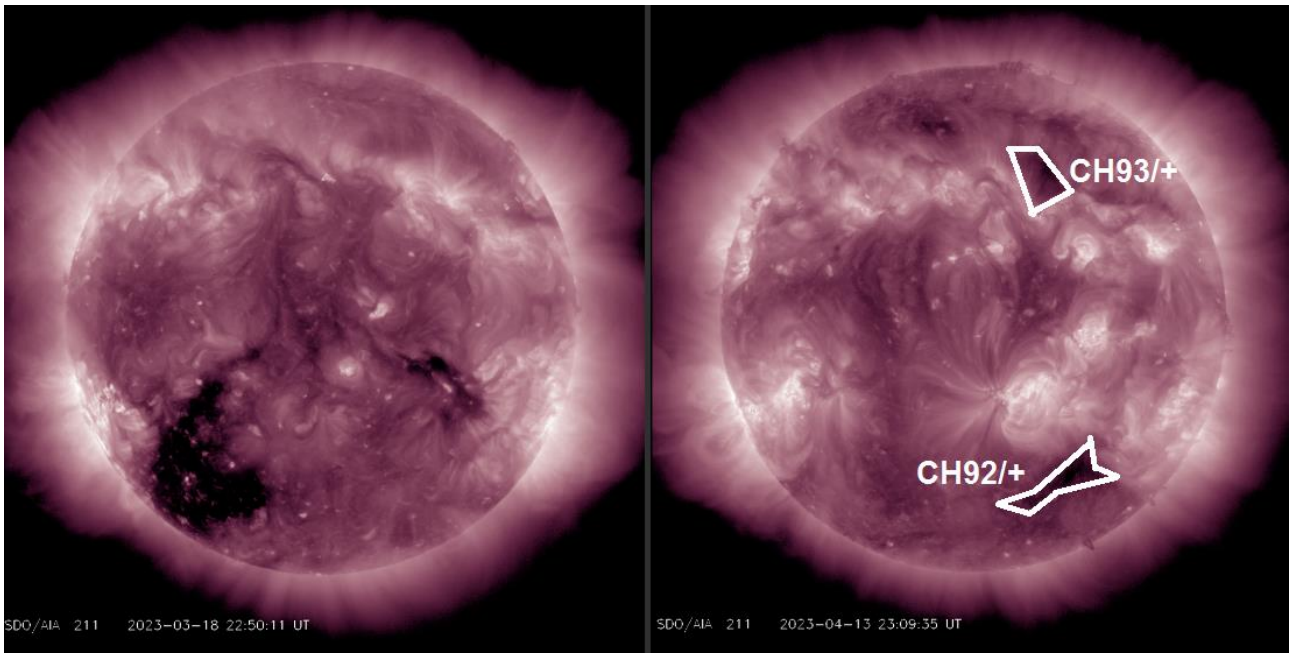
Figure 2: AIA211 imagery from the previous and current rotations, showing little resemblance in coronal holes, affording low confidence in the persistence forecast. The upcoming coronal holes' high latitudes render them less likely to be impactful, as well as their positive polarities.



Radio Blackouts - X-Ray Flares:

The current disc is the preserve of several bipolar regions of large span and number of constituent spots, but relatively small overall areas - especially in their penumbrae. Despite this, AR3279 and AR3272 have some history of M-class flares prior to midweek, and their class dictates that similar is possible in the lead-up to the UTC weekend. Adding to this risk are AR3281, which showed strong areal development in its leading spot, and also AR3280, which saw proliferation of spots and growth throughout.

None of the current front-sided regions are expected to leave the Earth-facing disc in the period, and indeed some of the recent main players appear to be maturing and decaying. Meanwhile the Carrington locations of up to five active regions are due over the eastern solar horizon in the four days. So, while the possible outlook is 'negative', any rise in flare probabilities will be factored into the forecast once they present for analysis on the eastern solar horizon.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

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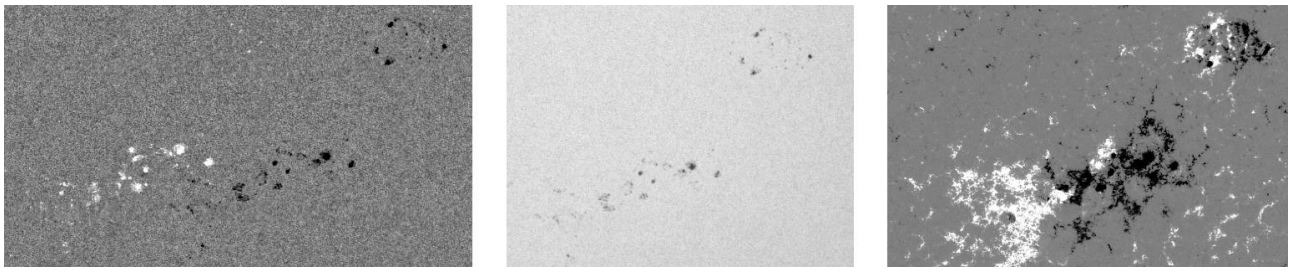
Figure 3: Left: Helioviewer.org-derived 24-hour difference in HMIIF footprint of sunspots AR3272 (bottom) and AR3280 (top), as at 12/0940UTC (white) and 13/0940UTC (black). Note the growth of AR3280 in particular. Middle: HMIIF imagery for same time; Right: HMIB for same time.



Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at Background levels through the period, however there is a very gradually increasing Slight Chance of a greater than S1 event, with AR3272 (in particular) transiting across the western hemisphere in the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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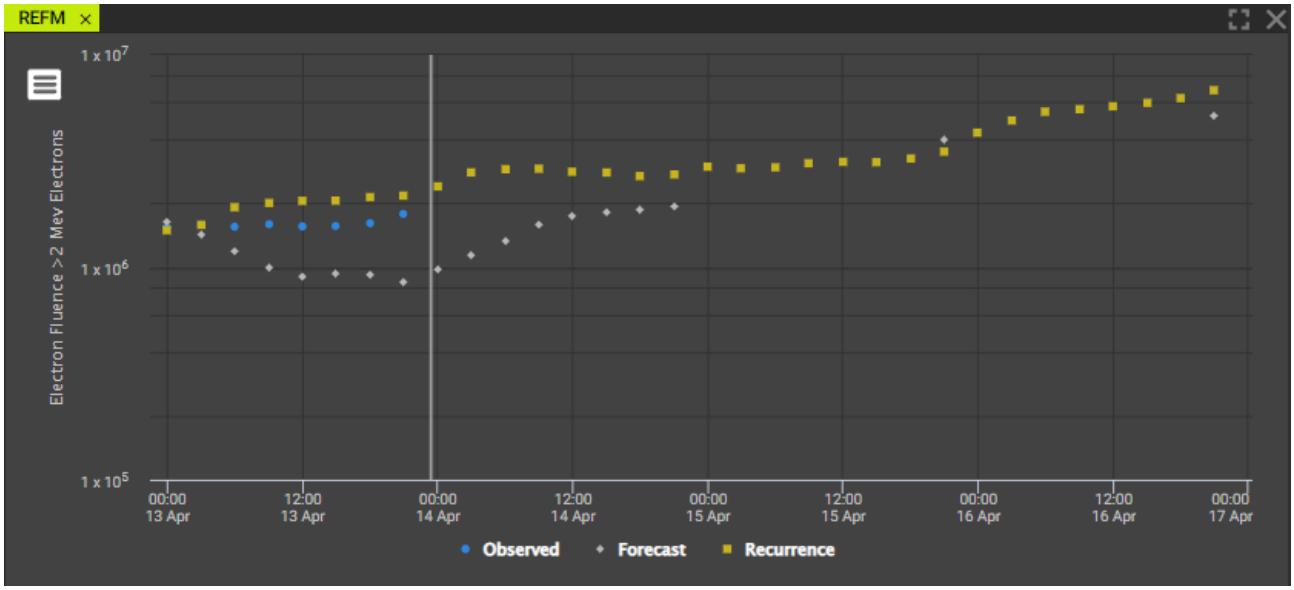
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux is currently at Normal Background levels, but may rise into the forthcoming UTC weekend in the likely absence of any significant geomagnetic activity. However, any rise is expected to be fairly modest and subject to uncertainty given the potential of glancing CME and HSS effects into the period.

The associated 24-hour integrated fluence is currently expected to be below the Active (1e8 integrated pfu) threshold throughout, but perhaps with a slight rising trend. MOSWOC REFM is suggesting only minor rises and is presently considered to be giving good guidance, albeit with the caveat that there are several low confidence CMEs that could feature in the forecast that REFM is not able to accommodate.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM, showing gradual rising trend in next 72 hours, albeit well below 1e8pfu, even at peak. This does not account for the marginal CME influence possible in the period, although the trend is otherwise accepted.



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